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BOOK REVIEWS

Non-Euclidean Geometry: A Critical and Historical Study of Its Development.

By ROBERTO BONOLA. Translated by H. S. CARSLAW. Chicago: The Open Court Publishing Co., 1912. Pp. xii+268. \$2.00.

Few, if any, of the modern developments of mathematics have struck the popular imagination in so pronounced a fashion as non-euclidean geometry and, perhaps we may say, deservedly so. For the discussion, which has clustered around this subject, in which great mathematicians, philosophers, and physicists have taken active part, has finally resulted, in our day, in a clear appreciation of the nature of such a mathematical science as geometry. Bonola's book is, therefore, an admirable introduction, not only to non-euclidean geometry, but to the vast domain of all of those important and fascinating discussions which are concerned with the foundations of mathematics.

The historical method of presentation, adopted by the author, is particularly well fitted for a treatment of this subject. The earliest commentators of Euclid found it impossible to accept his treatment of parallel lines with quite the same degree of approbation which they willingly extended to the rest of his geometry, and for more than two thousand years countless efforts were made to *prove* the fifth postulate upon which his theory of parallels was based.

When Saccheri (1667-1733) attempted to prove the necessity of Euclid's assumption by the method of *reductio ad absurdum*, he was on the threshold of the new science, which was not, however, finally entered until the days of J. Bolyai (1802-60) and Lobatschewsky (1793-1856). The history of the slow growth of this theory is most fascinating, and is well and accurately related in Bonola's work. A *full* appreciation of the later developments of non-euclidean geometry, associated with the names of Riemann, Beltrami, Cayley, Klein, Lie, Helmholtz, Clifford, Poincaré, and many others, requires a larger knowledge of advanced mathematics than Bonola wishes to presuppose. He does not, however, on that account, neglect to speak of these matters. He attempts, in a very satisfactory way, to make his readers acquainted with the general drift of these more modern investigations, explaining the theories in a semi-popular fashion and giving the more seriously inclined an opportunity to get into contact with the literature of the subject.

The translation is well done, although a few "idioms" of a decided Italian turn seem to have crept into the English version. For instance, we hear frequently (cf. p. 6) of two lines which "are not able to meet." It seems to be nearly impossible to preserve the instinct for idiomatic English while translating from a foreign language.

Lectures on Fundamental Concepts of Algebra and Geometry. By J. W. YOUNG.

Prepared for publication with the co-operation of W. W. DENTON. With a note on the growth of algebraic symbolism by U. G. MITCHELL. New York, Macmillan, 1911. Pp. vi+247. \$1.60.

Never, in the opinion of the reviewer, has such a clear and authoritative exposition of the fundamental notions of mathematics been presented to the general public. There are two very good reasons for this. In the first place, although the notions of